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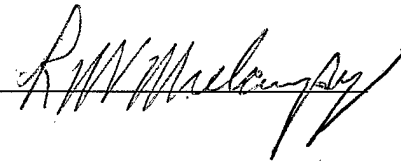
The Potential Role of Non-Lethal Weapons in the Maritime Environment

by

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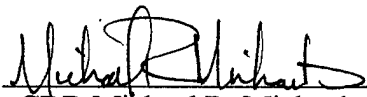
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The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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Abstract of

THE POTENTIAL ROLE OF NON-LETHAL WEAPONS IN THE
MARITIME ENVIRONMENT

The concept of non-lethal weapons has been the focus of increased attention and debate over the past decade. The conclusion of the Cold War, and the concurrent rise in the number and variety of "other than war" operations to which military forces have been committed, have produced an international security environment that defies simple solutions through the use of conventional weaponry. Most of the programs and writings to date, however, have focused almost exclusively on land-based usage of non-lethal weapons, consistent with the needs of peacekeeping and humanitarian mission forces.

This paper examines the potential for application of non-lethal weapons to operations in the maritime environment, and the possible benefits to be derived from this application to the Joint Force or Maritime Component Commander. Based upon promising technologies and employment concepts, research and development directed toward fielding non-lethal weapons for naval forces is recommended.

The scope and complexity of military operations in the 21st Century require providing military commanders with every possible instrument with which to accomplish national objectives. The advantages to be gained by applying non-lethal technology to naval operations are clearly worth pursuing. While they do not promise to yield "war without death," they have significant potential to aid in the execution of our national security and military strategies.

Today, world events mandate a need to project non-lethal force across all levels of war to enable our warfighters and leaders to effectively deal with a host of traditional as well as non-traditional threats. Now more than ever, the minimal level of public tolerance for collateral damage and loss of human life, coupled with the tendency for the typical adversary to exploit our rules of engagement to his benefit, necessitates an effective and flexible application of force through non-lethal weapons.¹

General James L. Jones
Commandant, United States Marine Corps

The concept of non-lethal weapons has been the focus of increased attention and debate over the past decade.² The conclusion of the Cold War, and the concurrent rise in the number and variety of “other than war” operations to which military forces have been committed, have produced an international security environment that defies simple solutions through the use of conventional weaponry.³ In 1996, the Department of Defense established the Joint Non-Lethal Weapons Program, with the U.S. Marine Corps acting as Executive Agent, to coordinate funding and research programs involving non-lethal technologies.

Most of the programs and writings to date, however, have focused almost exclusively on land-based usage, consistent with the needs of peacekeeping and humanitarian mission forces.⁴ This paper will discuss the potential for application of non-lethal weapons in the maritime environment. The investigation will examine social and political factors that encourage interest in non-lethal means, employment in the distant and recent past, the various non-lethal concepts and their possible suitability for naval use, and a general discussion of the utility of non-lethal force.

The Tolerance for Casualties

The allure of non-lethal weapons is self-evident. The prospect of “bloodless” warfare is particularly appealing following a century in which over 170 million lives were lost as a result

of armed conflict.⁵ The horrific carnage of World War I earned it the title “The War to End All Wars,” only to be followed two decades later by an even greater struggle. Although mankind managed to avoid war on a global scale over the last half of the century, the death and destruction wrought by localized conflicts has continued unabated in the Middle East, Africa, Southeast Asia, and numerous other arenas worldwide.

News coverage of military actions in recent years has given rise to the “CNN Effect” in which global media resources, employing advanced communications capabilities, are able to transport the battlefield nearly instantaneously into the living room. The steady stream of “real time” information, and concurrent analysis by commentators and subject experts, has led to more immediate public reaction than when these events were related via radio broadcasts and time-late newsreel clips. Lacking the benefit of a time filter, and the additional facts, perspective, and context it provides, national leaders are nevertheless expected to respond promptly to the developing situation. In this environment, particularly in cases where a direct threat to vital interests has not been clearly identified and articulated, public support for the mission is at best fragile, and heavy casualties can be very difficult to justify – American or otherwise.

The President’s 1999 National Security Strategy states that “Globalization – the process of accelerating economic, technological, cultural, and political integration – is bringing citizens from all continents closer together ...”⁶ This process has fostered a heightened awareness of the need to occupy the moral “high ground” both domestically and internationally, particularly in view of the influence of transnational coalitions and organizations. Again, according to the 1999 National Security Strategy:

Many of our security objectives are best achieved – or can only be achieved – by leveraging our influence and capabilities through international organizations, our alliances, or as a leader of an ad hoc coalition formed around a specific objective.⁷

During the Gulf War, concern over excessive Iraqi casualties and collateral damage permeated many aspects of the military operation, and spurred debate regarding the propriety of continuing the attack on retreating Iraqi army units.⁸

The quantity and nature of violence during conflict, particularly in “other than war” situations, will come under heavy scrutiny. This fact is prominently reflected in U.S. joint warfighting doctrine, which states that the goal of war “is to win as quickly and with as few casualties as possible.”⁹ Non-lethal means may provide a viable option when lethal force is undesirable:

The growing interest in nonlethality on the part of American policymakers and military strategists is a logical response to changes in the global security environment. Basically, it is part of the desire to preserve and enhance the political utility of military force. To have utility, a military force must be capable of attaining its objectives and be politically usable. If American political leaders feel that the use of force entails unacceptable political costs or pressures, the utility of even conventional forces will be limited. A number of features of the contemporary security environment may give armed forces equipped with both lethal and nonlethal weapons greater political utility than those which only have lethal means.¹⁰

Historical Development

Interest in the use of non-traditional armaments and munitions is not new. Riot control agents, defoliants, and rubber bullets have been used - with varying degrees of success - by military forces for decades.¹¹ Both sides of the political spectrum have been intrigued by their potential. Writing in 1968 in *Air Defense Review*, LtCol A. J. Celick noted that

As far back as 1959, Major General William M. Creasy, a former Chief of the Army Chemical Corps, suggested that the development of psychochemicals provided a means of waging war without death.¹²

An article in the *Journal for Peace Research* in 1965 argued that “waging war without killing, mutilation, or destruction of property is technologically feasible,” using “sonic pistols firing

invisible bludgeons of sound, tangle guns firing a mass of sticky, entrapping threads, ... new hypnotic or psychological weapons.”¹³ Indeed, some of the technologies currently being investigated for military application have existed for years.

Battlefield use of non-lethal technologies has been guarded. Although CS gas was employed in the earlier stages of the Vietnam conflict with some notable successes, its use declined as the war developed (partially due to outfitting of opposing forces with gas masks).¹⁴ More recently, carbon fiber spools delivered by cruise missiles were used during the Gulf War to impair the functioning of Iraqi power plants and electrical switching stations. These attacks were later followed by duplicate strikes with conventional ordnance, an apparent testament to the level of confidence military commanders had in these non-traditional weapons.¹⁵ During the withdrawal of U.N. peacekeepers from Somalia in 1995, U.S. forces were equipped with a variety of “off the shelf” items including:

- Sticky and aqueous foam
- Stinger grenades (rubber bullets vice metal shrapnel)
- Both 40mm and 12-gauge non-lethal munitions such as bean bags, rubber pellets, and wood baton rounds¹⁶

Although the opportunity to employ these weapons never materialized due to peaceful completion of the operation, some have argued that the existence of a non-lethal arsenal may have played a major role in deterring violence.¹⁷

The Current Landscape

What is a non-lethal weapon? The range of definitions encountered in the current literature suggests a complexity that belies the simple nature of the question. Even the terminology developed in recent years reflects this diversity: sublethal, less lethal, pre-lethal, less-than-lethal, soft kill, disabling.¹⁸ The official Department of Defense definition is found in

DoD Directive 3000.3, Policy for Non-Lethal Weapons, dated 9 July 1996:

Non-Lethal Weapons. Weapons that are explicitly designed and primarily employed so as to incapacitate personnel or materiel, while minimizing fatalities, permanent injury to personnel, and undesired damage to property and the environment.

The directive goes on to state that

Unlike conventional lethal weapons that destroy their targets principally through blast, penetration and fragmentation, non-lethal weapons employ means other than gross physical destruction to prevent the target from functioning.

Intent, both in design and employment, is the prime determinant of a weapon's lethality status. An unfortunate consequence of the term "non-lethal" is the unfounded expectation that no fatalities or serious injury will result. Regardless of the technology involved, some individuals will inevitably be more susceptible to its harmful effects than others. Asthmatics and persons with vascular weaknesses may have particularly adverse reactions to gases, and those with pacemakers might suffer life-threatening complications from devices that employ electric shock. Even the less exotic variety of non-lethal weapons, such as rubber bullets and wooden baton rounds, have resulted in wounds requiring hospitalization.¹⁹

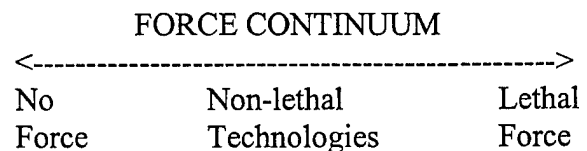
What non-lethal weapons can provide is a means of filling a gap in the force continuum.

Instead of limiting the decision maker to a

"yes" or "no" proposition regarding use of

lethal force, a method of proportional

response tailored to the specific scenario and circumstances may be possible.



Types of Non-Lethal Technologies

Although some of the specific applications currently under development are classified, both proven and potential technologies can be grouped into several broad categories. These categories are briefly described below.

Acoustic technologies involve the use of sound pressure waves transmitted through a medium such as air or water. The sound would normally be produced in a concentrated, focused manner in order to generate the energy necessary to impact the intended target. Appropriate selection of frequency and intensity allows the acoustic energy to be used against either material (resulting in structural damage) or personnel (yielding a "stun" effect).²⁰

Biological agents under consideration also can be employed against either personnel or material. Incapacitating and calmativ substances are chemicals that affect human behavior, producing symptoms such as nausea, fatigue, dizziness, unconsciousness, sensory irritation, and hallucinations. Biodeterioration, on the other hand, involves an attack on critical material items, such as fuel or internal lubricants, that renders them unusable.²¹

A vast array of *chemical products* have demonstrated potential for use in a non-lethal role. Items designed to attack components include embrittling substances that severely reduce material strength, anti-traction lubricants, vehicle combustion inhibitors, immobilizing adhesives, and corrosives/caustics that degrade specific materials. Some types of adhesives may be adaptable to use on personnel, and would complement sticky and viscous foams in the non-lethal anti-personnel arsenal.²²

Electro-magnetic concepts also cover a wide spectrum. Use of conductive materials to degrade electrical and electronics systems during Operation Desert Storm was discussed previously. Electro-magnetic pulses can induce disabling current surges in electrical equipment. Optical devices such as lasers and strobes may be employed against both personnel (causing disorientation or temporary blindness) and material. Electrical stun guns such as the Taser are currently used by law enforcement agencies.²³

Kinetic weapons include projectiles such as bean bags, rubber bullets, and wood batons.

Entanglers such as meshes, nets, and wire fabrications are designed to restrain either vehicles or personnel. One hybrid effort seeks to incorporate conductive materials in the nets in order to disrupt radio communications to and from the trapped vehicle.²⁴

Information warfare, and especially disruption of information systems, is considered by some to fall within the realm of non-lethal weapons.²⁵ With the rapid advance of computer technology, and the attendant reliance of many military systems on processor based components, effective use of computer viruses could significantly impact a potential adversary's ability to conduct even routine operations. A recent illustration of the devastating impact of information systems difficulties occurred at the National Imagery and Mapping Agency in August 1999. These problems, which were not the result of any form of computer "attack," significantly degraded critical satellite intelligence capabilities for several days.²⁶ However, since information warfare itself is not a "non-lethal weapon" as defined in the DoD Directive, it will not be considered in this paper.

Naval Applications

The variety of non-lethal technologies clearly demonstrates potential for use in land-based actions, particularly limited situations in which casualties and collateral damage must be kept to an absolute minimum. Can any of these developing technologies be adapted for naval use? This question must be addressed from two perspectives: the physical suitability of the technology for application in a naval environment, and the advantage afforded the Joint Force Commander by fielding the weapons. For simplicity, this illustrative discussion will focus on surface vessels, although logical extension to aircraft and submarines may be possible in some cases.

Non-Lethal Technologies in the Naval Environment

Warfare conducted in the maritime setting is fundamentally different from land warfare. Ground battles are waged between human beings in their native environment, and therefore can employ instruments that are effective against individual combatants, either singularly or in groups. Combat on water, however, is conducted in an essentially hostile environment in which ships function as shielding "fortresses"; as a result, the prime tactical objective is to damage the platform. The ultimate "enemy" often becomes the forces of nature, usually in the form of fire or flooding, that threaten the ship's survival. Bombs, missiles, torpedoes, projectiles - all are designed with the primary purpose of damaging the platform, not the individual combatants (crew members), although personnel casualties are certainly a byproduct.

Some of the non-lethal technologies will therefore find little practical application against most modern ocean-going combatant ships. The ability to quickly isolate external openings such as ventilation and still intakes - a basic defensive measure against traditional biological or chemical warfare attacks - will severely limit the utility of most non-lethal biological or chemical agents aimed at the ship's personnel or internal equipment (a key exception is noted below). Kinetic weapons directed against personnel would also be of limited value due to blue water standoff ranges and the fact that nearly all personnel are protected by the ship's structure.

There are, however, several concepts that do have potential for use against ocean-going platforms. Since the vast majority of tactical, fire control, and ship control systems are heavily dependent upon electronics, they are inherently susceptible to electro-magnetic pulses (EMP). A non-nuclear EMP warhead, delivered by cruise missile, aircraft, or even "pop-up" torpedo, could significantly impair the combat capability of the target by damaging critical systems.

Embrittling substances, corrosive/caustic agents, adhesives, and sticky foams may prove

useful against external fixtures such as deck-mounted guns, rocket launchers, and radar masts. Fracturing or corroding key weapons system components, sealing vital openings, disrupting automated system mechanical alignments, or fouling rail track surfaces would substantially complicate the ability to employ the affected weapons system.

Nearly all surface vessels rely upon some type of internal combustion process to provide main propulsion. An uninterrupted supply of air is required to support this process, presenting a vulnerability to chemical attack by combustion modifiers or corrosive agents that could render the platform immobile. Properly deployed propeller nets would also inhibit propulsion by fouling the ship's screw.

Operations in littoral regions offer additional opportunities for exploiting non-lethal technology. Those identified above as being suitable for use in blue water engagements would also function in littoral areas. However, some of the concepts excluded from blue water application offer potential for use in littoral environments due to the relatively compressed battlespace and the specialized, smaller coastal watercraft likely to be encountered. Ultrasound effects, for example, might be used in either an anti-personnel or anti-material mode against susceptible targets in line-of-sight geometries. Shrouds designed to inhibit electromagnetic emissions (communications, navigation, fire control) could be applied against coastal patrol boats. Optical or visual obscurants, such as specially designed paints, applied to pilot houses might render a boat crew effectively blind from its central control station. Additionally, the ability of these smaller craft to withstand chemical and biological attacks is generally not as robust as that of blue water combatants, making them more susceptible to neutralization by these methods.

The full range of non-lethal weaponry is particularly well suited for use in maritime

interdictions and specialized force applications such as SEAL operations. Many aspects of these missions are similar in nature to small scale ground force and law enforcement missions, which often involve close contact between individual opponents. Boarding or insertion teams equipped with non-lethal devices would be able to carry out sensitive operations with a reduced risk of inflicting casualties.

Obstacles

Translating several of these concepts into effective weapons will involve overcoming scientific and engineering challenges. Research efforts in the acoustic and EMP area continue to grapple with limitations in the ability to generate sufficient energy, properly focused, to achieve desired effects on a consistent basis.²⁷ Many of the chemical agents designed to impair mechanical systems presently function too slowly to have immediate tactical impact. Embrittling effects are often reversed without repeat applications.²⁸ Finally, delivery methods present a daunting problem for some of the technologies being considered.

Some other hurdles include:

- Legal issues. Several international treaties, including the 1925 Geneva Protocol, the 1972 Biological Weapons Convention, and the 1993 Chemical Weapons Convention, prohibit or strictly limit use and stockpiling of chemical and biological substances. Although interpretations tend to vary concerning what constitutes a "chemical weapon" and under what defensive conditions substances such as riot-control agents may be used, most analysts agree that tactical use in most military engagements is prohibited.²⁹ The prevailing sentiment among a number of policy makers was reflected by Han Swyter, a DOD staff expert in chemical and biological warfare issues, during testimony before Congress in 1969:

The Geneva Protocol is a major step in the direction of non-proliferation. It has provided the norm for international law and practice for 45 years. Tear gas and

defoliants, as we are using them in Vietnam, tend to weaken the protocol. Our use enlarges a loop-hole. It tends to allow one kind of chemical and not another. Distinguishing among chemicals is not practical, no matter how good the intention³⁰

Although articulated over thirty years ago, concern over the “slippery slope” of chemical and biological weapons usage is just as relevant today.

Any weapons that, despite being non-lethal, result in undue suffering or permanent injury potentially violate the Law of Armed Conflict. Thus, adhesives that refuse to separate from skin, sticky foam that routinely suffocates its target, and lasers that are designed or employed to permanently blind personnel would not be viable options.

- Countermeasures. The very nature of many non-lethal technologies make them particularly vulnerable to neutralization. Gas masks and forced-air breathing devices have been used for years to counteract chemical agents. Optical effects such as lasers and strobe lights can be filtered with specially designed eye protection.³¹ Simple body armor can in some cases render non-penetrating projectiles and electric stun guns ineffective.

The same technology that promises to yield sophisticated non-lethal weaponry may also hold the key to its defeat.³² Active noise cancellation, already being used in platform quieting applications, can disrupt acoustic energy waves. A similar concept might be developed to counter directed-energy microwaves.

- Reliability and Assessability. Compared to conventional battle damage assessment, determining the effectiveness of non-lethal attacks in the battlespace may prove difficult. Many of the technologies do not result in large scale deformation or visible destruction. This will result in a heavier reliance on target response as an indicator of weapon effectiveness, which is less reliable and more subject to enemy deception. The uncertainty will generally be greater with higher level technologies applied at greater distances.

The ability to achieve consistent results across a broad range of conditions varies considerably among the various concepts. Weather in particular may degrade the effectiveness of the majority of chemical agents.³³ EMP-induced current surges can be reduced by the “shadowing” provided by the platform’s structure, which is highly dependent upon geometric aspect.

- Effects on Personnel. In practice it may prove difficult to achieve anti-material effects without incurring personnel casualties.³⁴ Sealing hatches and access covers can asphyxiate those trapped inside if no other means of escape exist. A ship without electronic navigation capability may collide or ground, risking substantial loss of life. Superadhesives applied to equipment could easily be deposited on personnel; although these agents are designed with low affinity for skin adhesion, a variety of environmental factors could complicate removal, resulting in undue suffering. Additionally, the long-term effects of personnel exposure to any of the substances under consideration may not be clear - our own past experiences with Agent Orange underscore the need to carefully and completely evaluate proposed applications in order to avoid unintended consequences.

Despite these challenges, non-lethal technologies have the potential to provide additional tools to the operational commander that span the gap between “no force” and “lethal force”. Some appear more feasible than others, but only development and testing will confirm the suitability of the various concepts.

Significance For The Joint Force Commander

How will filling the void in the maritime force continuum benefit the Joint Force Commander? Full scale combat operations will still likely rely upon lethal force as the primary means of mission accomplishment. Although non-lethals may find utility in specific

engagements in which casualties or collateral damage must be minimized (similar to the initial use of carbon fiber spools in the Gulf War), interests that require the use of full military force generally warrant employing the lethal arsenal.

The true potential for non-lethal weapons use in naval warfare is in operations short of war and in the control of escalation of hostilities. While the death and destruction resulting from waging full war with lethal means serve to break the will to resist, the opposite is often true in the incipient stages of a crisis – use of lethal force may solidify popular support for a defiant posture and spur calls for retaliation, or may splinter a fragile coalition of international forces. The use of non-lethal methods - disabling the combat capability or maneuverability of a unit, capturing it outright, neutralizing one of its primary weapons systems, or making it particularly susceptible to lethal attack - is far less provocative. This communicates a clear signal of resolve, while simultaneously demonstrating a desire to settle the issue peacefully.

Maritime Interception Operations (MIOs) often present challenges in which non-lethal means may prove beneficial. The initial stages of the MIO in support of United Nations Security Council Resolution sanctions against Iraq in August 1990 were beset by concerns regarding use of force:

The operational plan considered the danger that unnecessary use of force at the early stages of the crisis might undercut international support for the sanctions or even prompt an Iraqi military response at an inopportune time relative to Coalition building and Operation Desert Shield force deployment.³⁵

Strict controls were implemented to regulate conduct of escalatory actions: Naval Forces Component, Central Command (NAVCENT) permission was required for warning shots, and disabling fire required approval of the National Command Authority.³⁶ Despite use of warning shots, three Iraqi tankers refused to comply with challenges rendered by U.S. Naval Forces

between 18 and 31 August. Short of using disabling fire or a "takedown" – insertion of forces via helicopter – all options had been exhausted and the tankers proceeded without being boarded.

Consider the possibilities, however, had non-lethal weapons been available. A combustion inhibitor delivered by aircraft, cruise missile, or unmanned vehicle could remove propulsion capability, facilitating small boat boarding. A propeller mesh would have a similar effect. Sealant applied to cargo accesses or other deck structures may convince the captain to submit rather than risk further damage. An EMP-induced loss of electronic piloting and ship control systems might restrict maneuverability and complicate efforts to conduct the intended transit.

All of these options involve use of force on a scale below that of disabling fire. Although several may cause damage to the ship's equipment, the non-lethal nature of the force could provide the task force commander a more suitable alternative to those currently available. This would have been particularly helpful in the 1990 Gulf MIO in view of the shortage of helicopter assets necessary to conduct takedown operations.³⁷ Additionally, use of the less provocative non-lethal measures would permit delegation of employment authority to lower echelons, providing increased operational flexibility.

Non-lethal weapons would enhance the ability to execute tailored responses in any number of special situations. In fisheries cases, for example, the U.S. Coast Guard law enforcement procedures mandate extreme restraint in the use of force, in part due to concern over international and domestic public reaction.³⁸ This restraint precludes use of disabling or warning fires. However, the introduction of non-lethal weapons would significantly expand the range of options available. Low-level use of sonic energy, either in the anti-personnel or anti-material mode, may be sufficient to induce compliance. Anti-traction substances would severely inhibit

topside fishing operations, while embrittling substances properly applied could disable net handling machinery. In each case, the means selected by the operational commander would be based upon the unique circumstances involved.

There are, of course, limitations and employment factors that must be weighed when considering use of non-lethal weapons. Most platforms targeted by non-lethals will only be able to respond with lethal force, thus risking elevation of hostilities despite the attempt to control escalation.³⁹ An overly “predictable” engagement protocol could negate the deterrent effect of conventional arms, and may dilute the impact of surprise in future operations:

By employing nonlethal means, the U.S. or coalition would place an adversary on notice that lethal attacks may follow. At that point the adversary may well be on a heightened alert status, increasing the risk to friendly forces should it be necessary to intervene with traditional forces. If it becomes “expected” that the U.S., for moral or political reasons, will employ nonlethal means as the weapons of first resort, it may be at the expense of operational surprise in subsequent use of force.⁴⁰

Despite these pitfalls, the ability to expand the choices available to leaders when confronting complex crises, particularly in view of today’s political realities and the ever-changing global security environment, should be fully exploited. Non-lethal concepts directly support the key principles of *restraint* and *legitimacy* in operations short of war.⁴¹ Provided they are employed with a full appreciation and understanding of their benefits and limitations, they have the potential to provide the military commander an additional resource with which to shape the security environment in support of the National Military Strategy.

Recommendations

While several non-lethal technologies have demonstrated utility on the ground, little effort has been directed toward evaluating the potential for naval use. Although research and experimentation may eliminate some candidates from practical application, others may prove

surprisingly suitable. In view of the foregoing discussion of the various concepts, the following recommendations should be adopted.

- Expand efforts within the existing framework of the U.S. Marine Corps Executive Agent organization to apply non-lethal technologies to naval warfare. The most promising concepts should receive priority, as follows:

- EMP and microwave high energy transmissions
- Combustion inhibitors
- Meshes and nets (both electromagnetic shielding and propeller entangling)
- Superadhesives and sealants
- Lasers
- Acoustics

Some will find ready application with only nominal adaptive effort; others will present a significant challenge. These challenges should be identified and pursued as determined by the benefits to be derived from fielding a weapon based upon the technology. Only through research, development, and testing can the "possible" be distinguished from the "impossible."

- Incorporate employment of non-lethal force into existing naval doctrine, once the process of procuring specific weapons has begun. This effort should be geared toward providing the Joint Force or Naval Component Commander additional tools for use across the force continuum. Employment should focus on use in efforts other than war, and in specialized interdiction operations.

This doctrine should reflect that for maximum effectiveness, the use of non-lethal force must be supported by an apparent latent lethal capacity that is both capable and credible. Just as the lack of lethal potential may encourage an opponent, so too will the perceived lack of will to use it. The full benefit of non-lethal weapons will only be realized when all participants are aware that lethal force can – and will – be used if other lesser measures do not succeed.

- Rules of Engagement should be updated to reflect the availability of non-lethal weapons once deployed. One of the major difficulties in crafting and implementing rules of engagement is the tendency of the enemy to expose and exploit the defined boundaries. The addition of non-lethal means simply increases the number of these boundaries. Both standing and specified rules of engagement will need to address the option of non-lethal weapons use with careful consideration of the capabilities and limitations involved.

Conclusion

The scope and complexity of military operations in the 21st Century require providing Joint Commanders with every possible instrument with which to accomplish national objectives. The advantages to be gained by applying non-lethal technology to naval operations are clearly worth pursuing. While they do not promise to yield “war without death,” they have significant potential to aid in the execution of our national security and military strategies.

ENDNOTES

¹ Excerpt from the Joint Non-Lethal Weapons Program Homepage, www.usmc.mil/nlw, 27 April 2000.

² See for example Nick Lewer and Steven Schofield, Non-Lethal Weapons: A Fatal Attraction? (London: Zed Publishers, 1997), 1; David A. Morehouse, Nonlethal Weapons: War Without Death (Westport, CT: Praeger Publishers, 1996), 3; Douglas C. Lovelace and Steven Metz, Nonlethality and American Land Power: Strategic Context and Operational Concepts (Carlisle, PA: U.S. Army War College, 1998), 2-4.

³ Malcolm Dando, A New Form of Warfare: The Rise of Non-Lethal Weapons (London: Brassey's Publishing, 1996), 1-4.

⁴ Lovelace and Metz, 3.

⁵ Morehouse, 7.

⁶ National Security Strategy for a New Century, (The White House, 1999), 1.

⁷ Ibid, 3.

⁸ Michael R. Gordon and Bernard E. Trainor, The Generals' War (Canada: Little, Brown and Co., 1995), 406.

⁹ Joint Chiefs of Staff, Doctrine for Joint Operations (Joint Pub 3-0)(Washington, D.C.: 1 February 1995), vii.

¹⁰ Lovelace and Metz, 6.

¹¹ Lexi Alexander and Julia L. Klare, The Role of Non-Lethal Technologies in Operations Other Than War (Alexandria, VA: Institute for Defense Analyses, 1996), 10.

¹² Dando, 10.

¹³ Ibid

¹⁴ Ibid, 77. Discussion of additional aspects of chemical weapons will occur later in the paper.

¹⁵ Ibid, 19.

¹⁶ Timothy J. Lamb, Emerging Nonlethal Weapons Technology and Strategic Policy Implications for 21st Century Warfare (Carlisle, PA: U.S. Army War College, 1998), 14.

¹⁷ Ibid, 15.

¹⁸ Alexander and Klare, 4.

¹⁹ Ibid

²⁰ Lewer and Schofield, 11.

²¹ Ibid, 12.

²² Ibid

²³ Ibid, 11.

²⁴ Ibid, 13.

²⁵ Dando, 12.

²⁶ James Risen, "Computer Ills Meant U.S. Couldn't Read Its Spy Photographs," The New York Times, 12 April 2000, A1.

²⁷ Lewer and Schofield, 40.

²⁸ Morehouse, 119.

²⁹ Dando, 80.

³⁰ Dando, 81.

³¹ Alexander and Klare, 32.

³² John Barry, Michael Everett, and Allen Peck, Nonlethal Military Means: New Leverage for a New Era (Cambridge, MA: Harvard University, 1994), 14.

³³ Alexander and Klare, 31.

³⁴ Ibid, 16.

³⁵ Department of Defense, Conduct of the Persian Gulf War: Final Report to Congress (Washington, 1992), 62-63.

³⁶ Ibid, 68-69.

³⁷ Ibid, 80.

³⁸ Transportation Department, U.S. Coast Guard Maritime Law Enforcement Manual, USCGCOMINST M16247.1A Ch-2, 4-8.

³⁹ Barry, Everett, and Peck, 15.

⁴⁰ Ibid, 14.

⁴¹ Joint Chiefs of Staff, Joint Doctrine for Military Operations Other Than War (Joint Pub 3-07)(Washington: 1995), II-2.

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